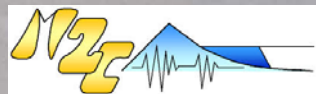
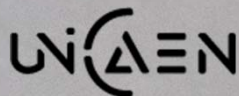


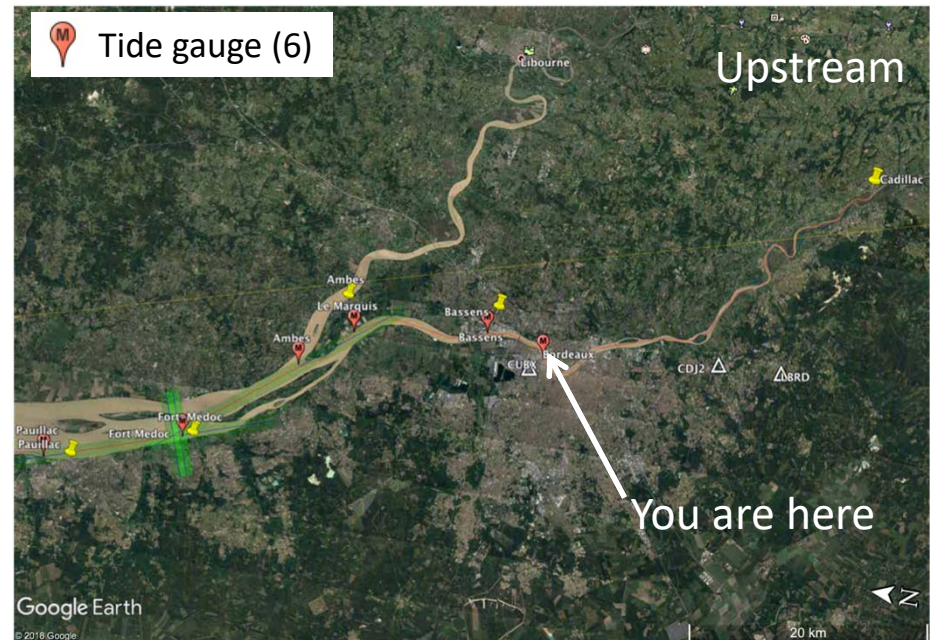
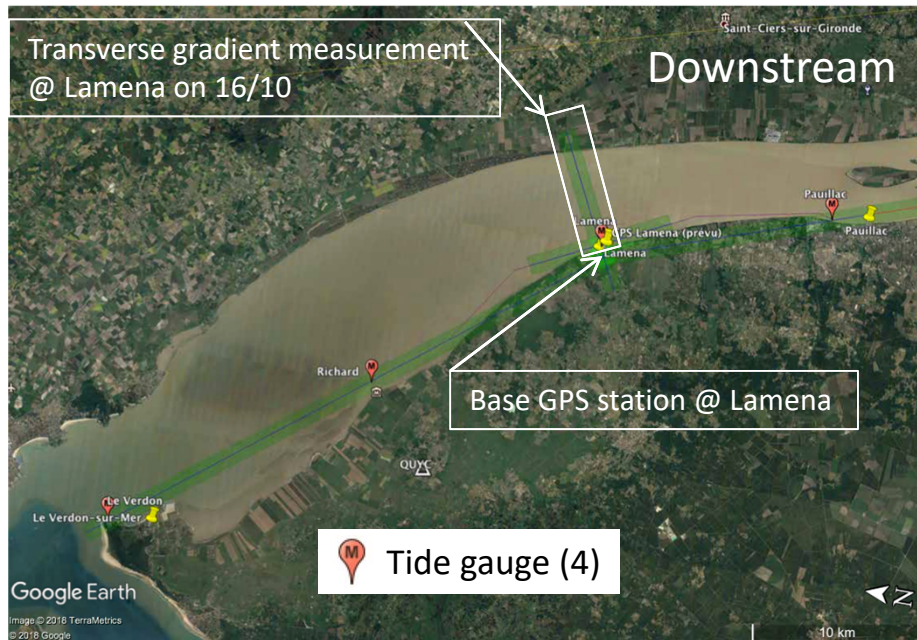
# Gironde Campaign, October 2018

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## General Description

- 2 measurement zones (outward on 16/10/2018 and return on 17/10/2018):
  - Downstream: Pauillac <-> Verdon + transept to Lamena (CalNaGeo1, Cyclopée, HyDrones) => 133 km round trip
  - Upstream: Pauillac <-> Cadillac (CalNaGeo2) => 172 km round trip
- Airborne LIDAR measurements on downstream zone and part of the upstream zone (done 1 week later because of the weather)
- 2 buoy measurements at Langon and La Réole tide gauges + Airborne LIDAR



## Instruments (1/2)

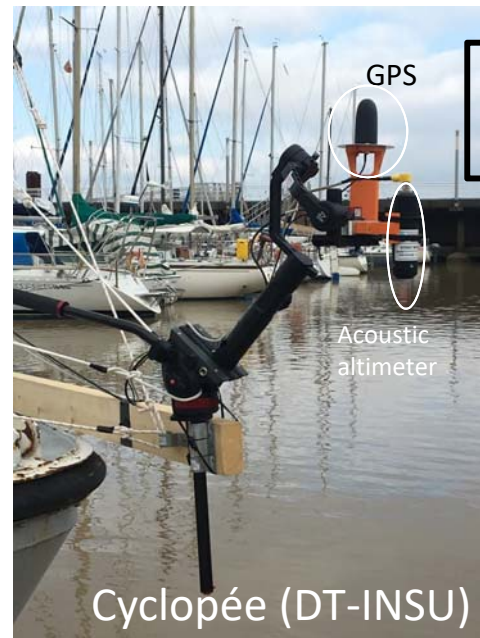
### Downstream:

Co-located measurements (time/space) of 3 instruments:

- CalNaGeo
  - Cyclopée (radar+GPS+gyrostabilisation)
  - HyDrones on drone (Azur Drones)
- + comparisons with a buoy at Lamena

### Upstream:

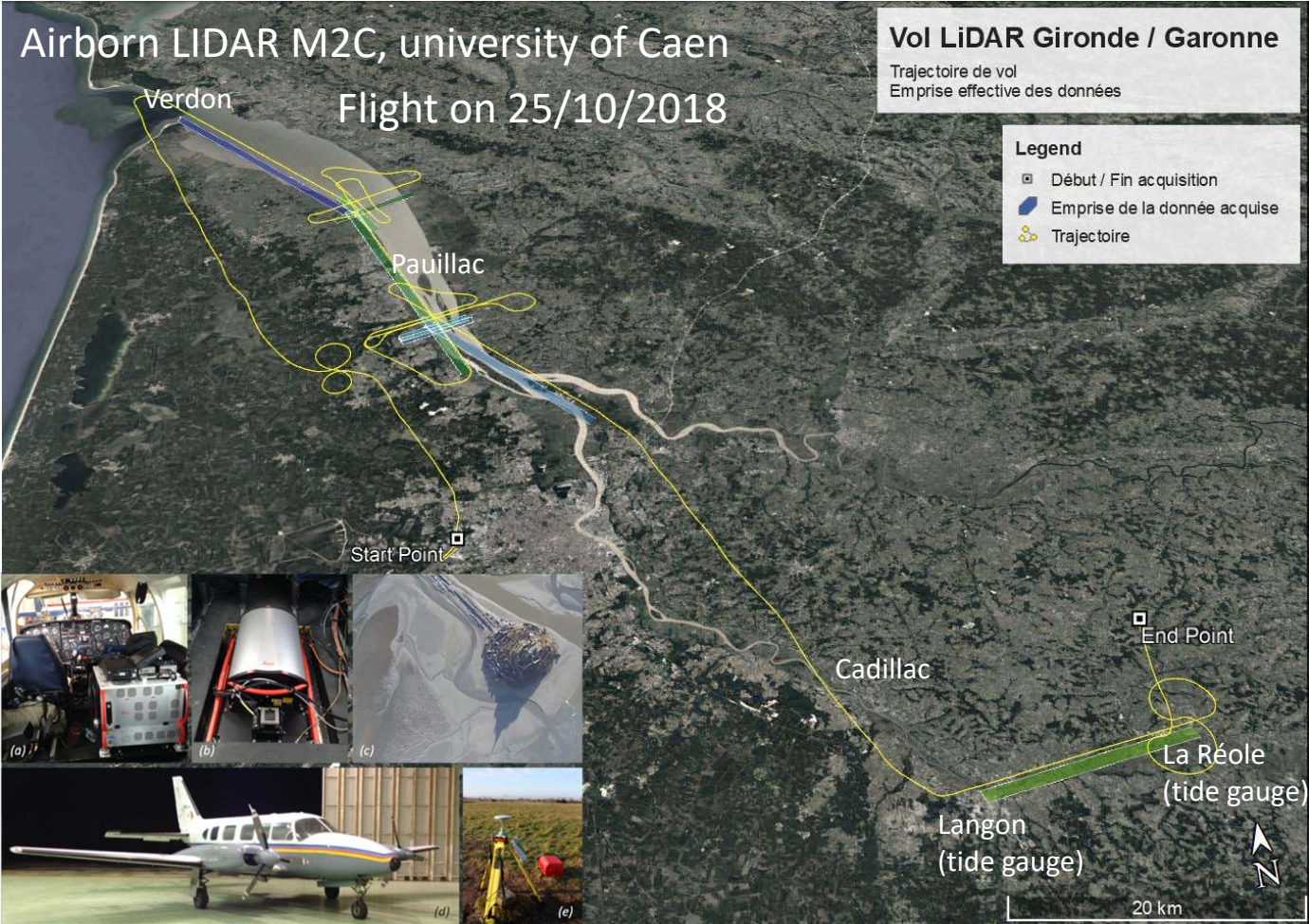
- CalNaGeo (+ADCP)
- Buoy (Langon et La Réole)



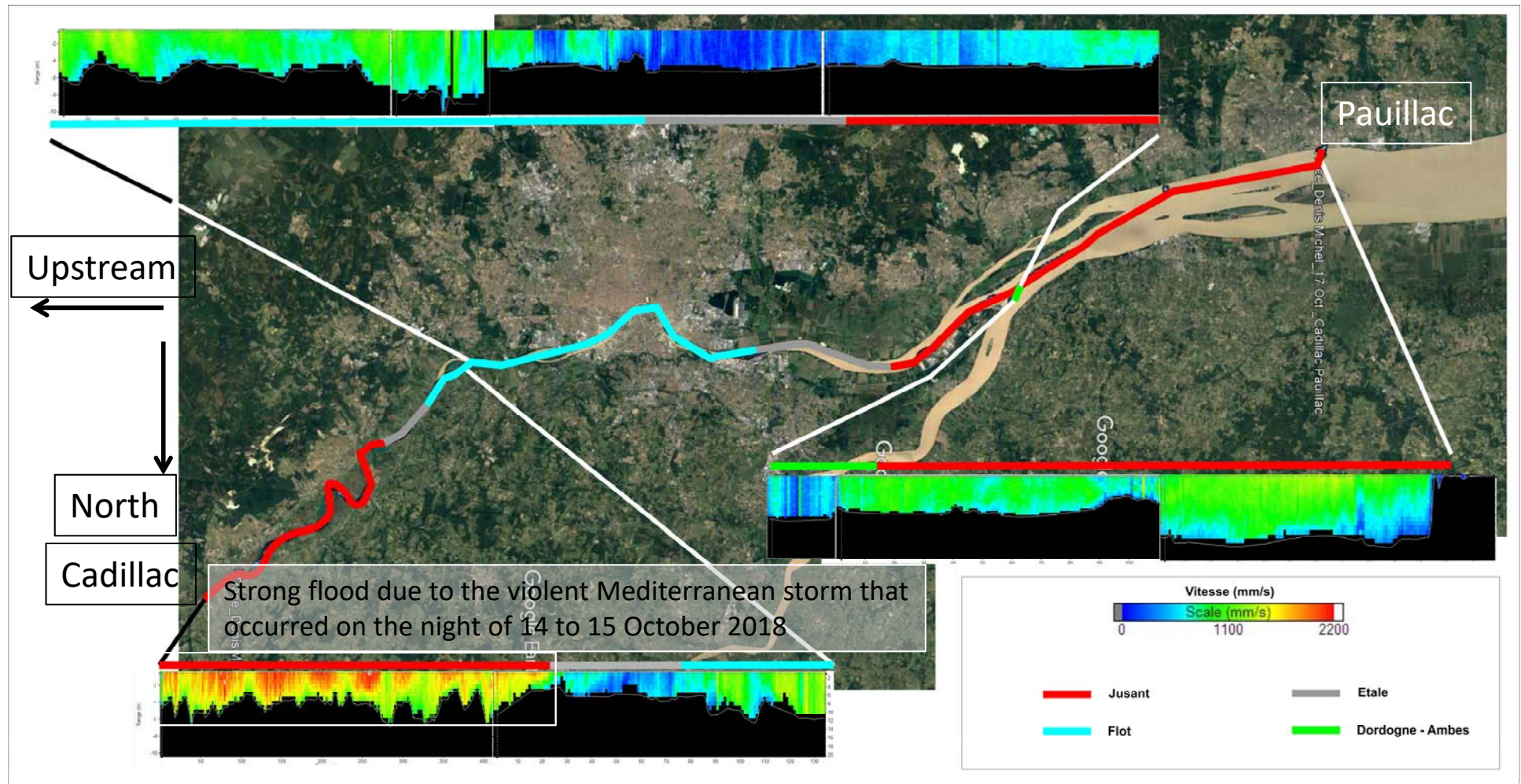
+ 12  
Tide gauges



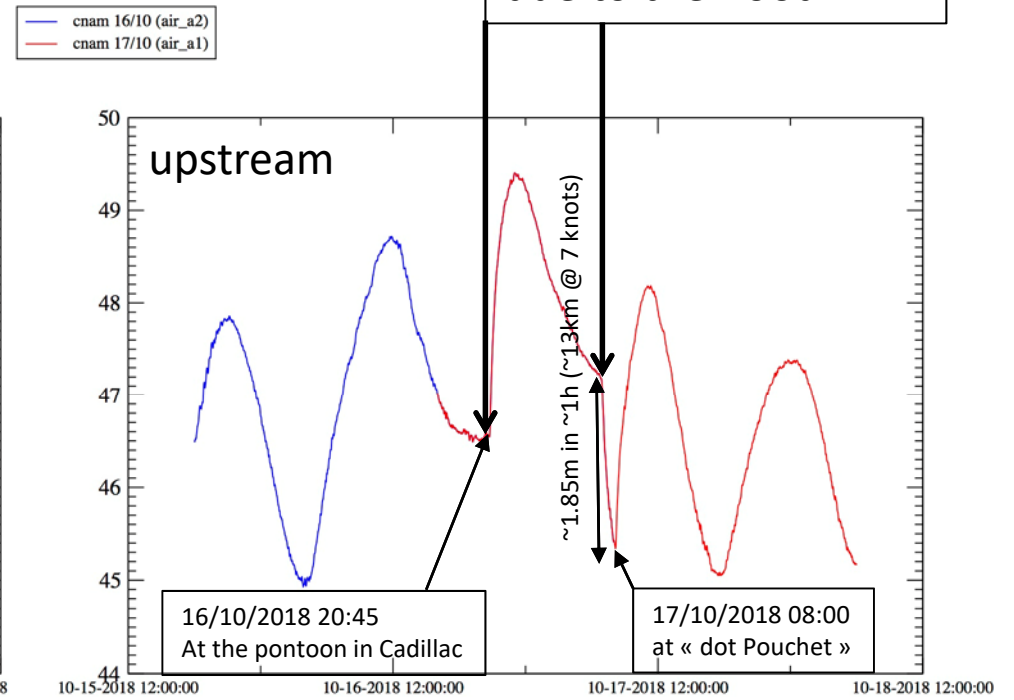
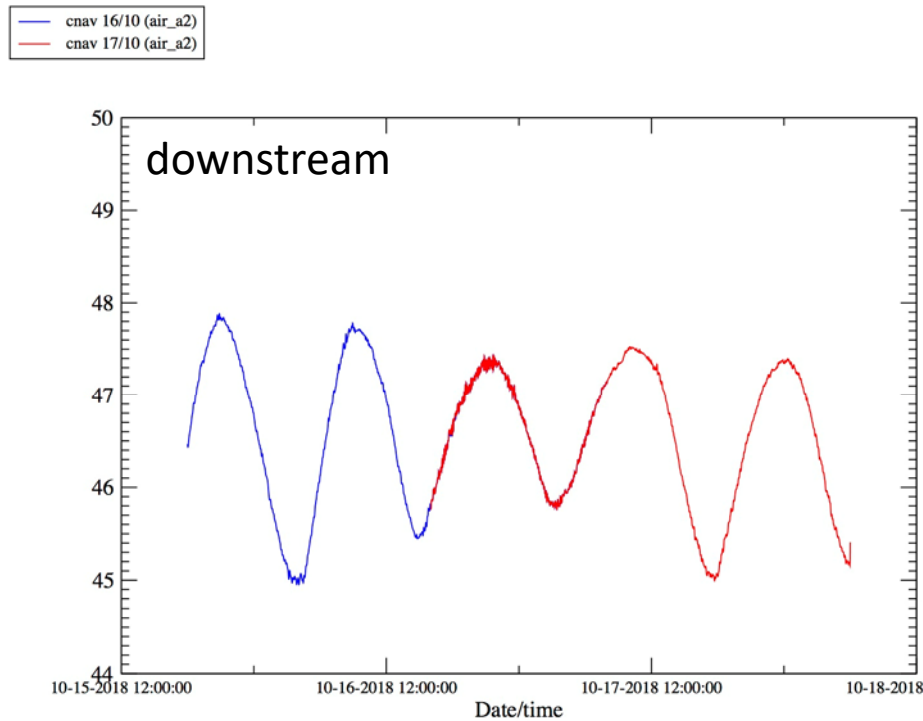
# Instruments (2/2)



# ADCP measurements on 17/10/2018 between Cadillac and Pauillac



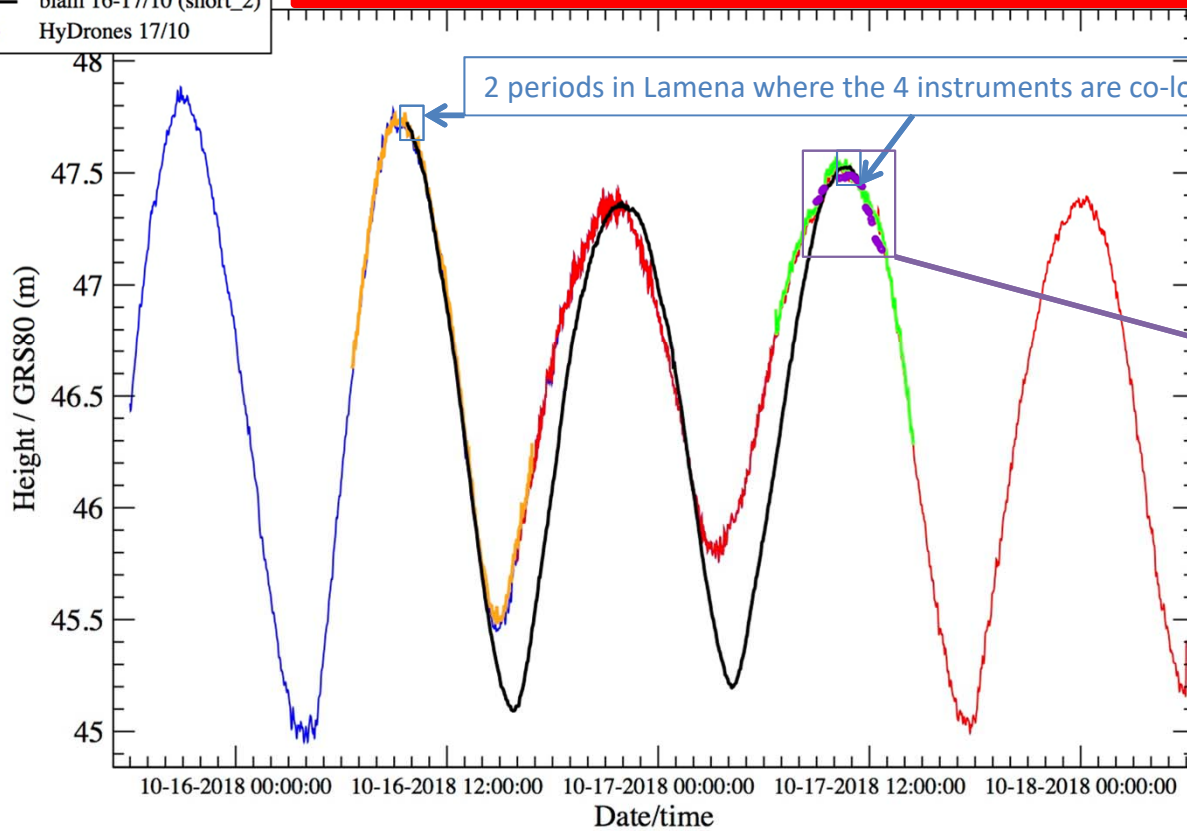
# GPS Solutions 15-17 (blue) & 16-18 October (red) for CalNaGeo downstream and upstream



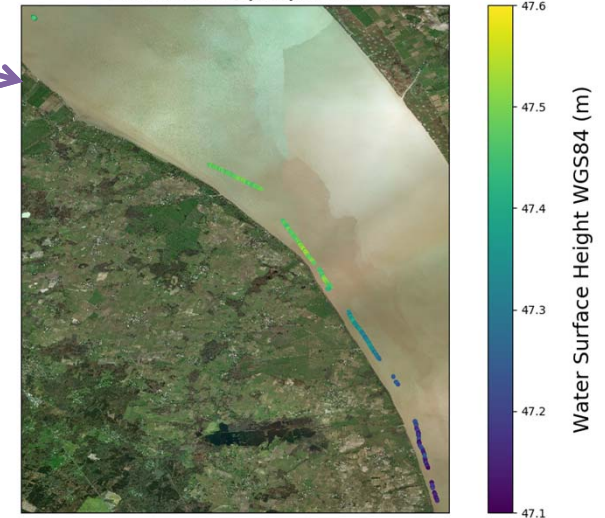
Downstream: CalNaGeo (blue/red), Cyclopée (orange/green), Buoy (black) and HyDrones (purple)

- cnav 16/10 (air\_a2)
- cnav 17/10 (air\_a2)
- cycl 16/10 (air\_a1)
- cycl 17/10 (air\_a1)
- blam 16-17/10 (short\_2)
- HyDrones 17/10

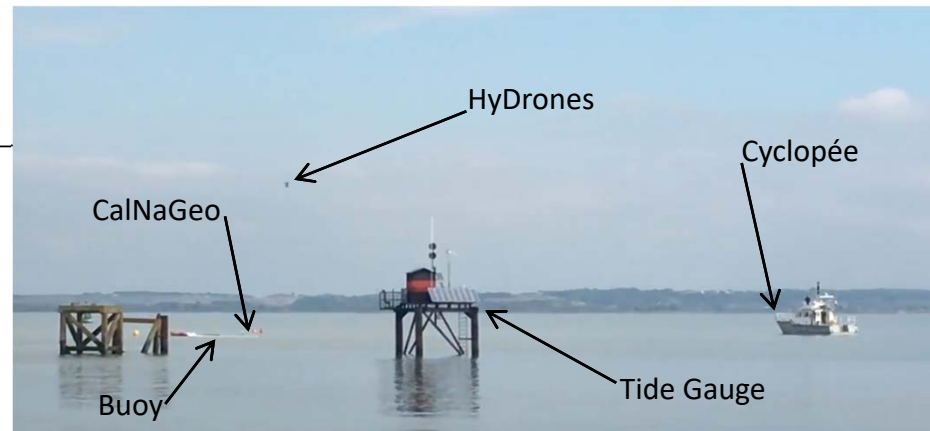
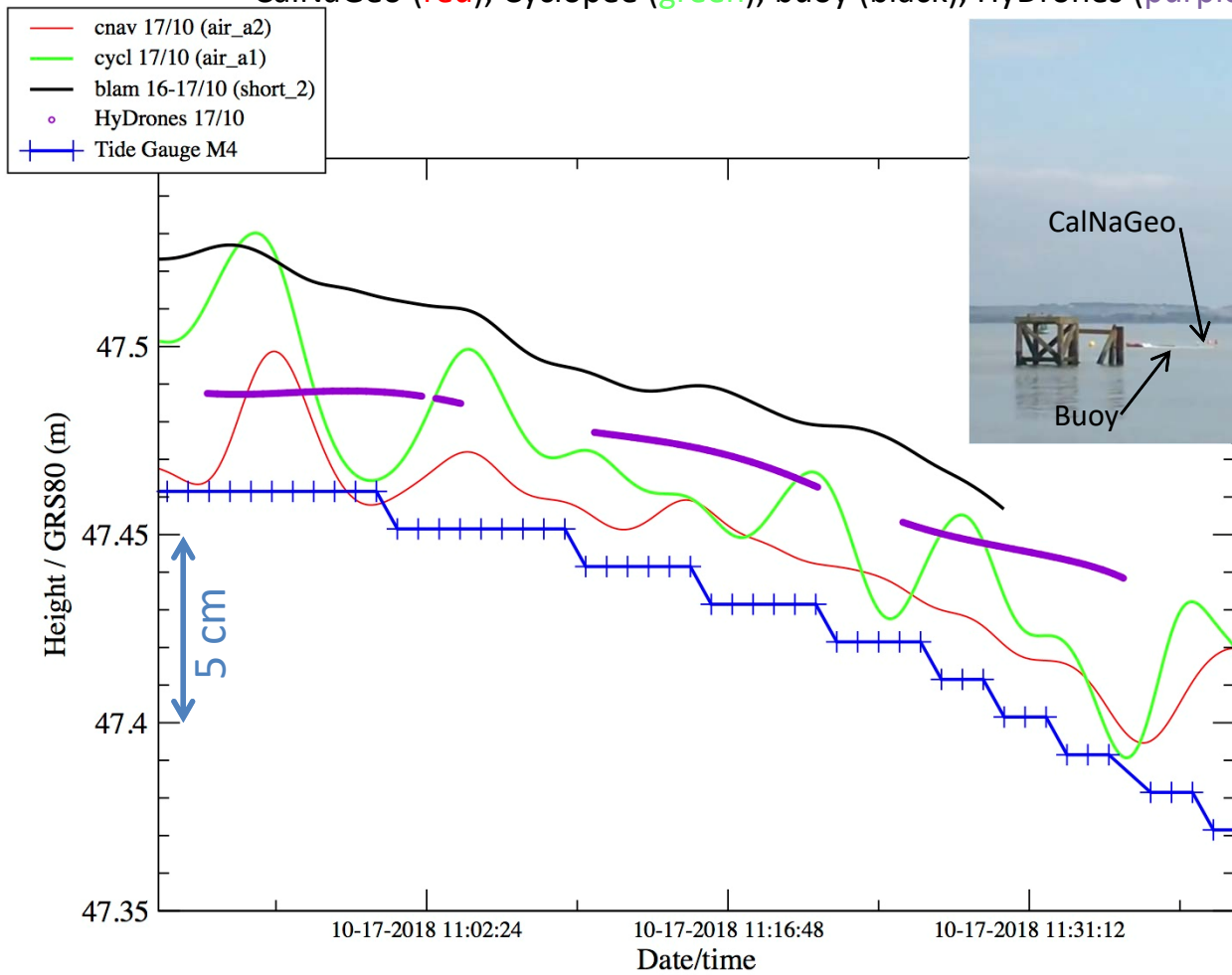
Raw measurements (1 Hz) are smoothed with a low-pass filter at 300 seconds (~ 1 km @ 6 knots)



HyDrones WSH in the Gironde estuary  
Lamena 17/10/2018



Common measurements at Lamena (17/10/2018):  
 CalNaGeo (red), Cyclopée (green), buoy (black), HyDrones (purple) and M4 tide gauge (blue)

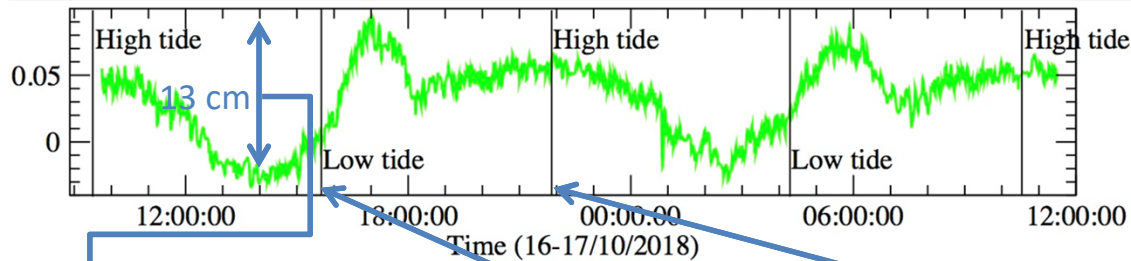


Steps due to centimetric's rounding in tide gauge data...



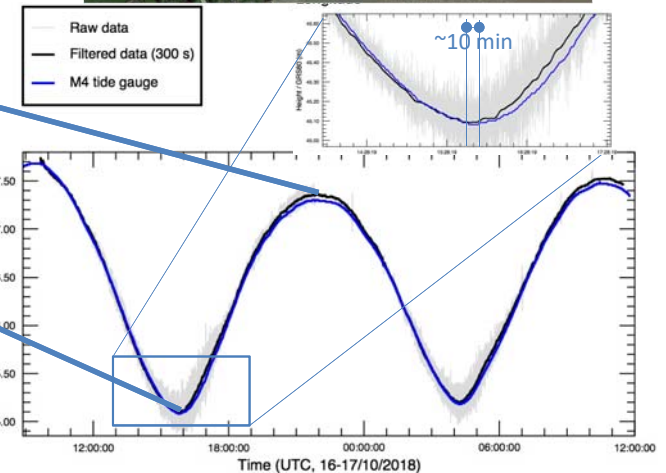
Common measurements buoy (**black**) and M4 tide gauge (**blue**) over 2 days at Lamena (16-17/10)

Differences Buoy – Tide Gauge: mean = + 33 mm / rms = 28 mm

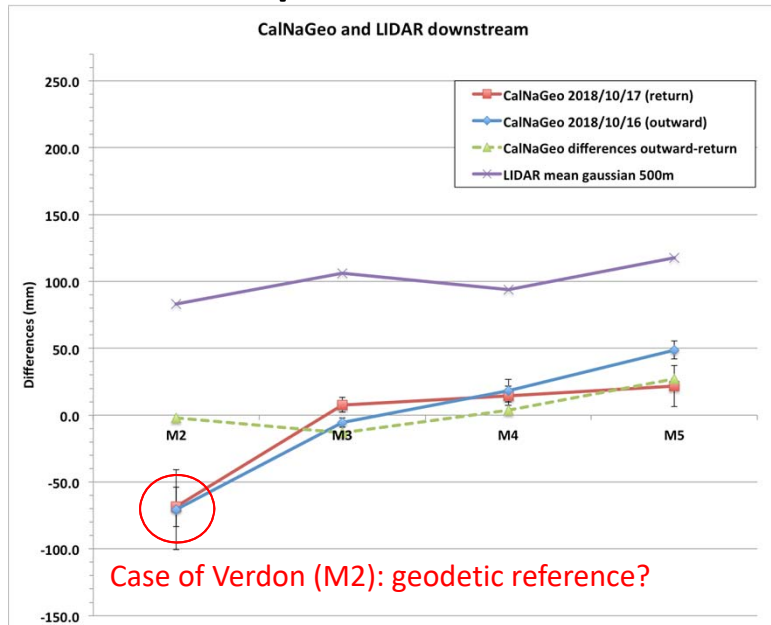


**Unexpected signal !**  
Differences up to 13 cm peak to peak  
@ less than 150 m:

- Higher waves during low tides?
- Sinkage effect of the buoy due to current (strength on the cable)?
- **Problem in datation (during high gradient up to 10 cm in 10 min)?**



# Comparisons with tide gauges for CalNaGeo and LIDAR



**CalNaGeo:** without Verdon (M2)

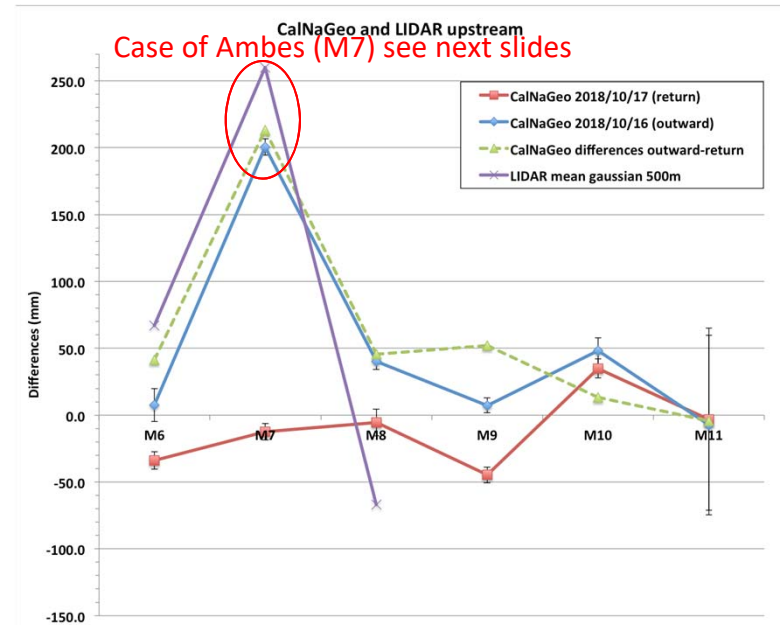
Outward: mean = +21 mm / rms = 27 mm

Return: mean = +15 mm / rms = 7 mm

Outward-Return differences: mean = +6 mm / rms = 20 mm

**LIDAR:** without Verdon (M2)

2018/10/25: mean = +106 mm / rms = 12 mm



**CalNaGeo:** without Ambes (M7)

Outward: mean = +19 mm / rms = 24 mm

Return: mean = -11 mm / rms = 31 mm

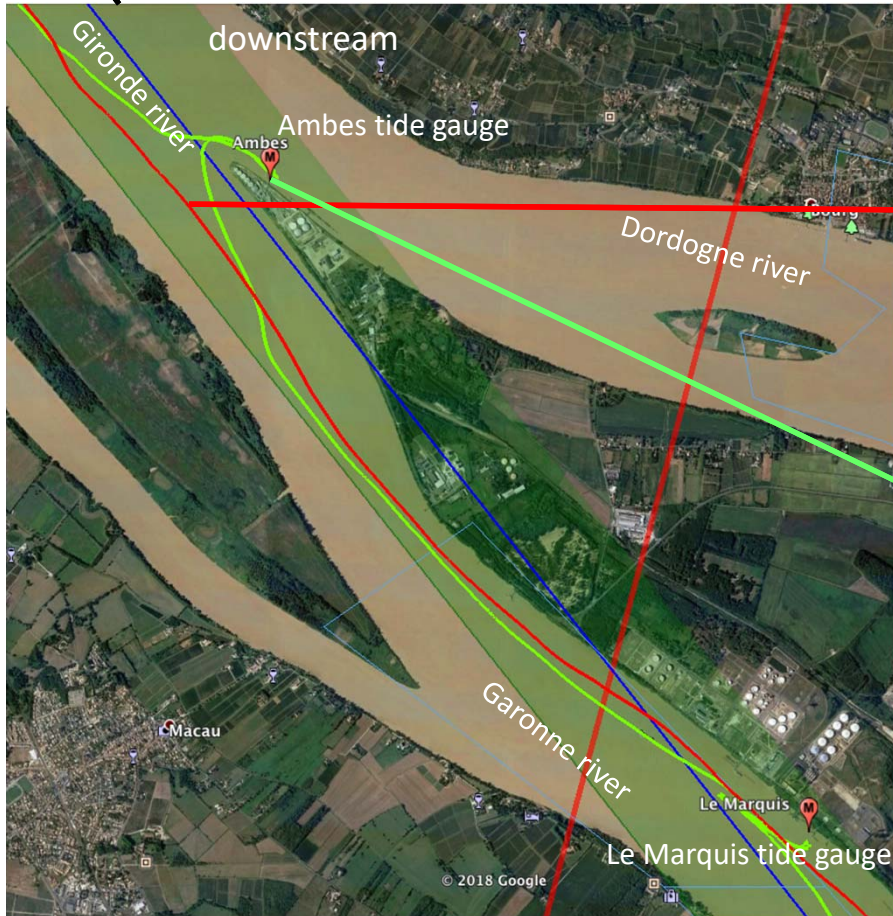
Outward-Return differences: mean = +30 mm / rms = 24 mm

**LIDAR:** without Verdon (M2)

2018/10/25: mean = +0 mm / rms = 95 mm

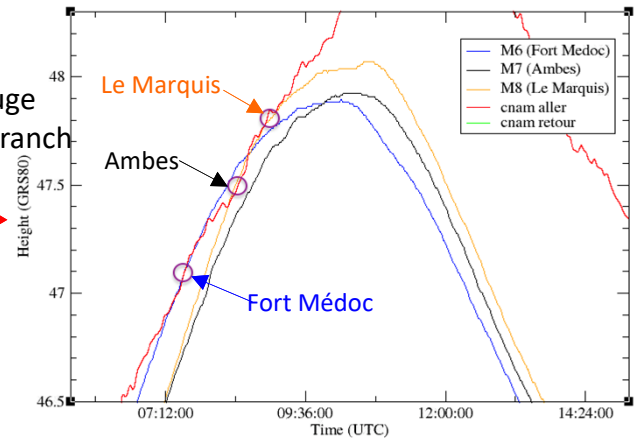
# Impact of non co-located measurements: CalNaGeo

Fort Médoc  
tide gauge



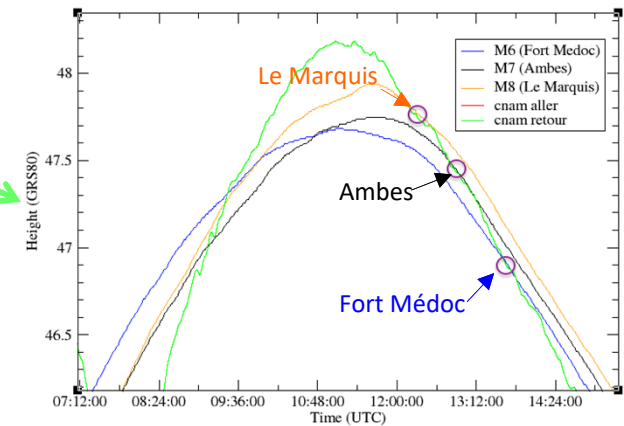
## Outward journey:

Far (500 m) from the tide gauge  
And NOT on the same river branch  
=> Difference = 200 mm

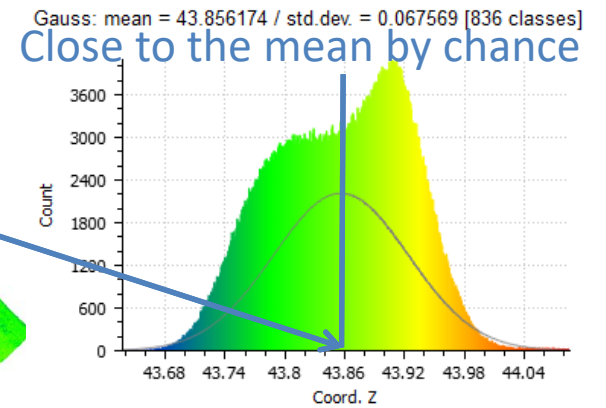
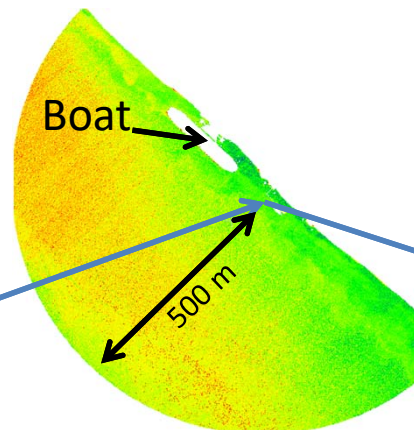
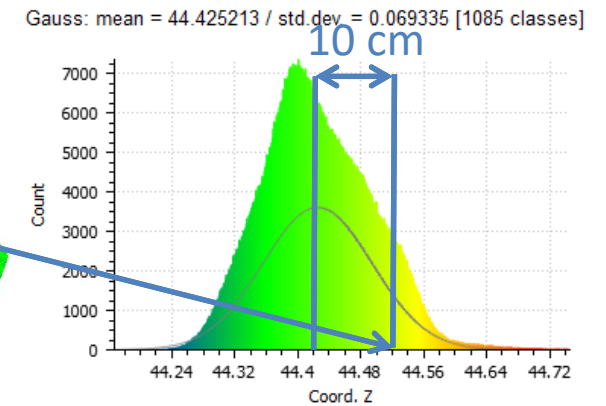
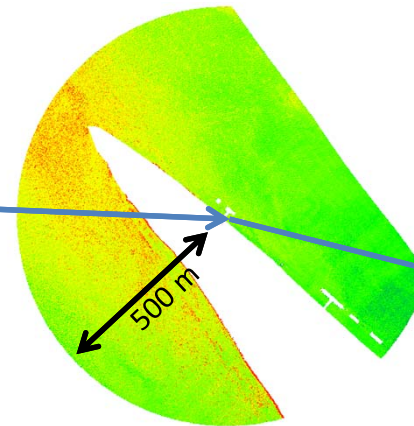
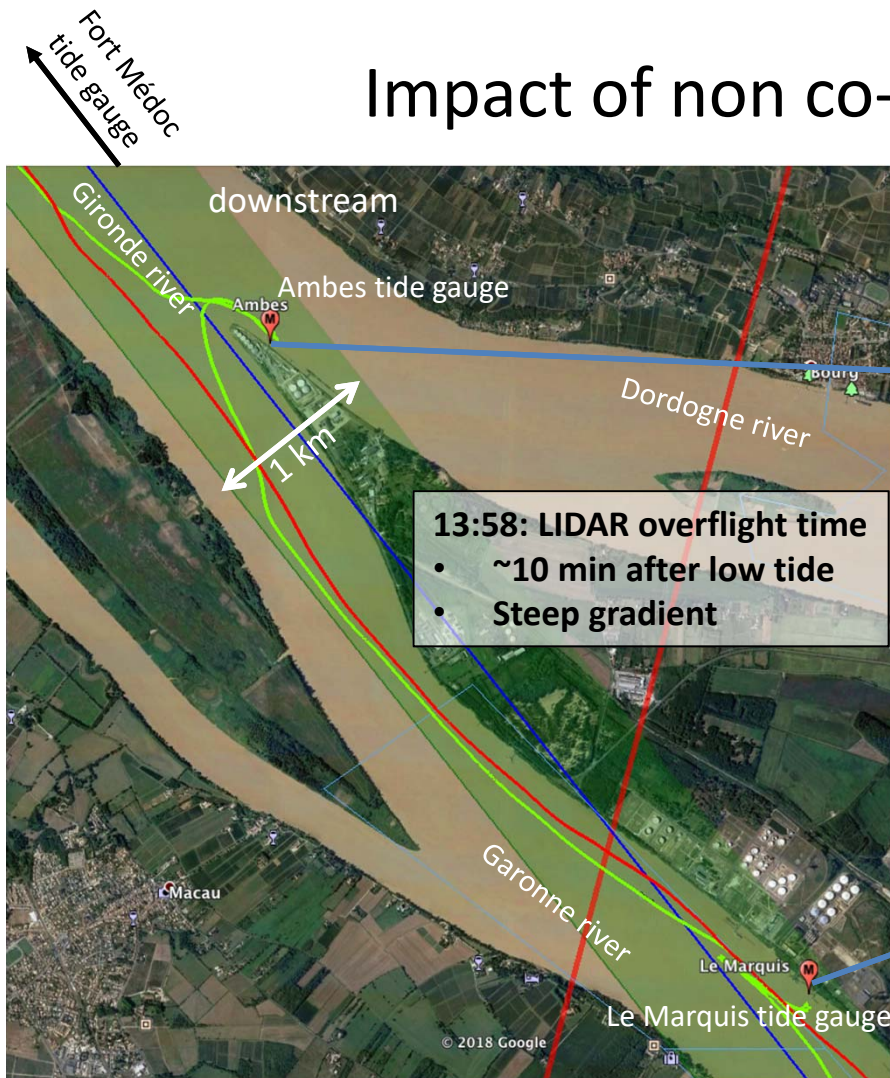


## Return journey:

At the tide gauge  
And on the same river branch  
=> Difference = -13 mm



# Impact of non co-located measurements: **LIDAR**



## Conclusions (1/2)

- Comparisons between **CalNaGeo, Cyclopée, HyDrones and buoy:**

Differences / buoy (@Lamena, static)	16/10/2018	17/10/2018
CalNaGeo - buoy	~-33 mm for the 2 days ( $\sigma \sim 6$ mm)	
Cyclopée - buoy	~-24 mm for the 2 days ( $\sigma \sim 14$ mm)	
HyDrones - buoy		~-19 mm ( $\sigma \sim 5$ mm)

⇒ **Offset of ~2-3 cm compare to the buoy**

Differences on all the data	@Lamena
Cyclopée – CalNaGeo	~+10 mm ( $\sigma \sim 10$ mm)
Cyclopée – HyDrones	~-15 mm ( $\sigma \sim 13$ mm)
CalNaGeo – HyDrones	~-22 mm ( $\sigma \sim 5$ mm)

⇒ **Offsets of ~1-2 cm between the 3 instruments**

⇒ **Very good coherence with the different instruments at 1-2 cm rms**

- Comparisons of **CalNaGeo and LIDAR with tide gauges:**
  - **CalNaGeo:** 24 mm rms globally  
same level for Outward-Return differences
  - **LIDAR:** 75 mm rms globally  
clear ~100 mm offset probably due to too large averaging (500 m)  
but only 12 mm rms for downstream

## Conclusions (2/2)

- **Is in situ giving the truth?**

As shown, local effects can impact the comparisons with tide gauges:

- Distance: strong effects (tens of cm) increased in particular conditions (river branches)
- Datation: up to 10 cm for time tagging error of several minutes depending water level time gradient (strong tides in estuaries)
- Geodetic referencing uncertainty: several cm (often only based on geoid grid instead of accurate leveling)

- **Using existing networks of instruments is a good opportunity**

- **But they were not all designed to achieve our level of accuracy**

- **If we want to meet our requirements we must end-to-end design, install and monitor our in situ instruments**

Backup slides

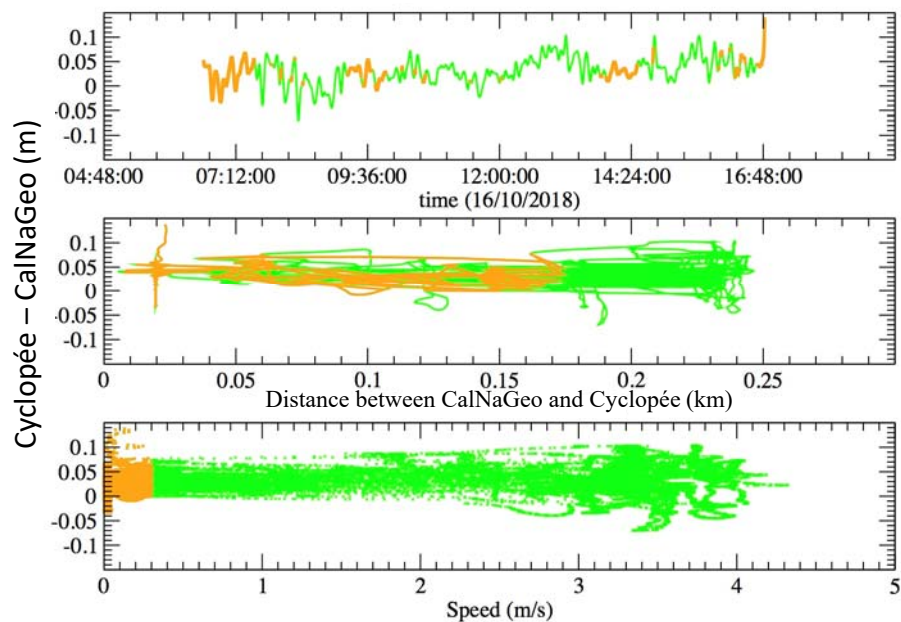
# Comparisons over the whole downstream path



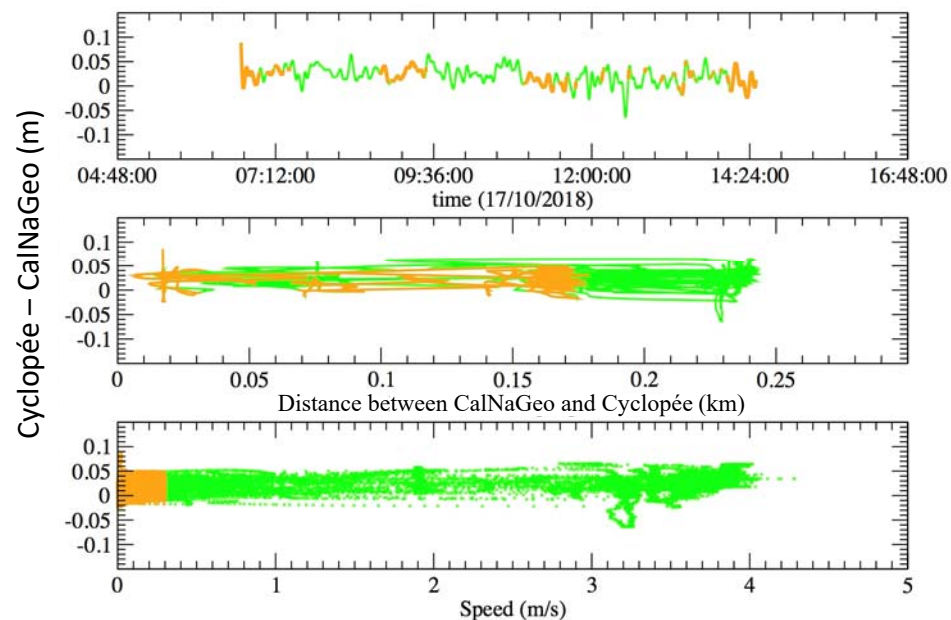


# Comparisons Cyclopée — CalNaGeo

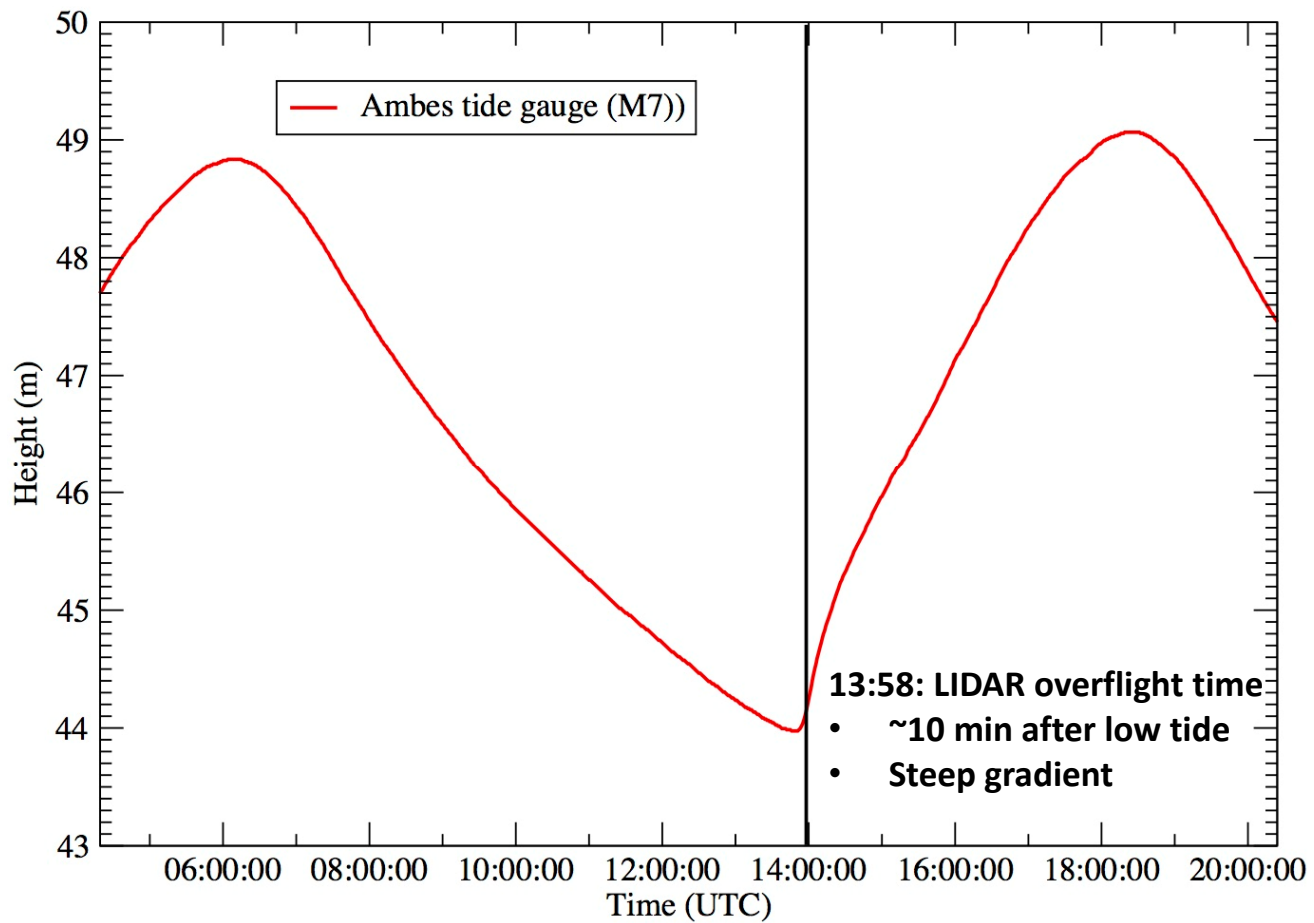
Cyclopee Experiment @ GIRONDE (Track mode air)



Cyclopee Experiment @ GIRONDE (Track mode air)



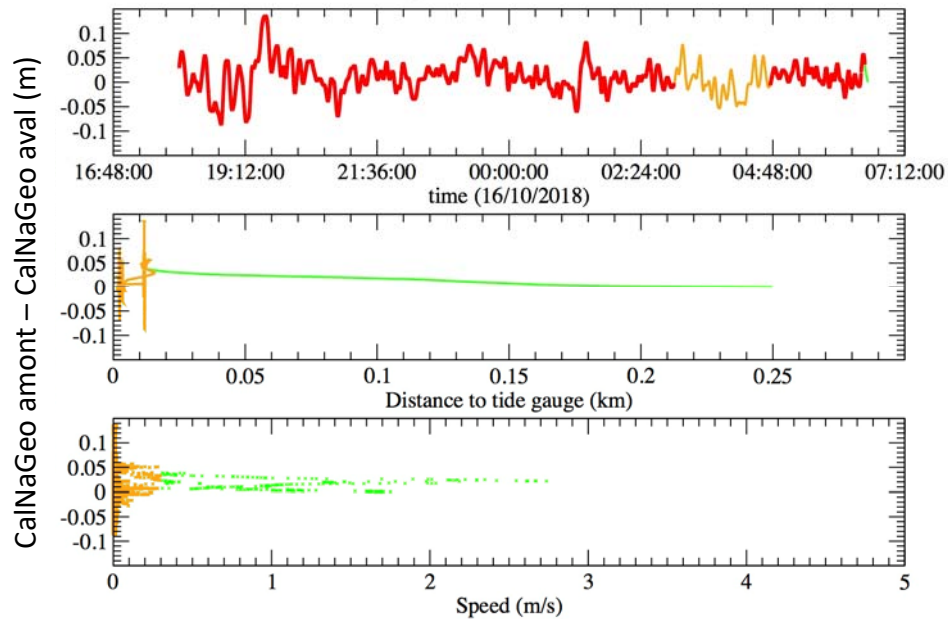
Date	Type	Mean (mm)	$\sigma$ (mm)	N
16/10/18	D<250m	31.2	26.3	36596
16/10/18	D<250m + V<0.3m/s	27.2	20.7	8373
17/10/18	D<250m	21.3	17.3	28047
17/10/18	D<250m + V<0.3m/s	18.1	16.1	6907



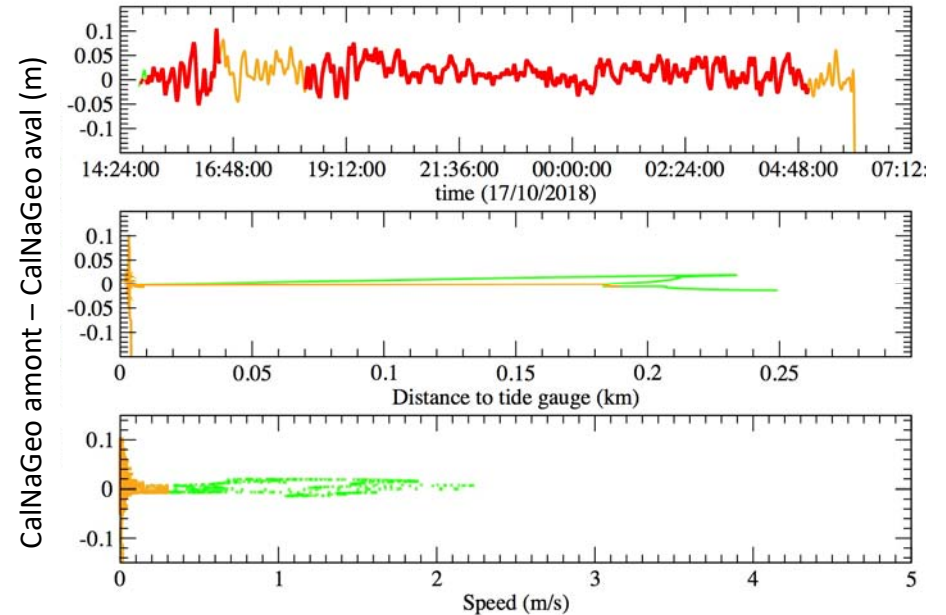
# CalNaGeo Comparisons upstream – CalNaGeo downstream @ Pauillac

RED= apart from the low tide at Pauillac

CalNaGeo upstream Experiment @ GIRONDE (Track mode air)

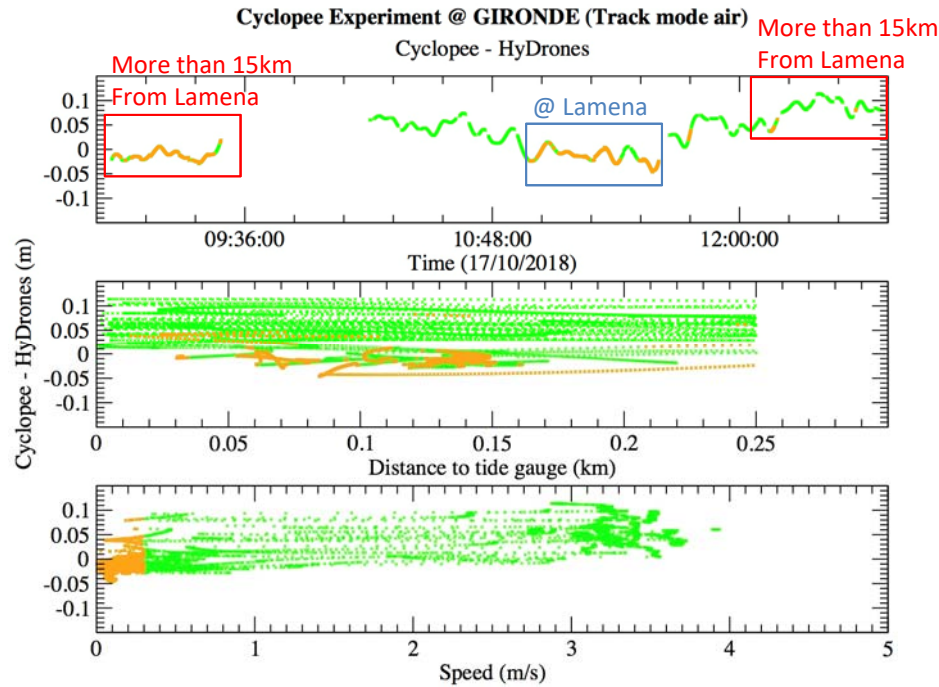


CalNaGeo upstream Experiment @ GIRONDE (Track mode air)



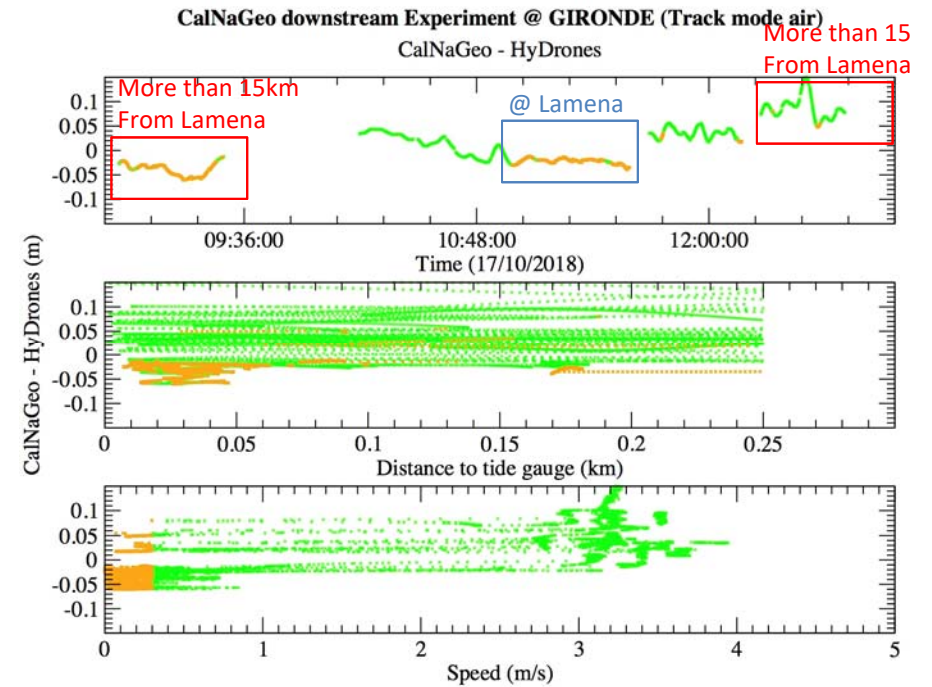
Date	Type	Mean (mm)	$\sigma$ (mm)	N
15-16/10/18	D<250m	10.3	31.0	45156
15-16/10/18	D<250m + V<0.3m/s	10.2	31.0	44904
16-17/10/18	D<250m	13.9	22.6	54745
16-17/10/18	D<250m + V<0.3m/s	14.0	22.7	54127

# Comparisons Cyclopée & CalNaGeo — Hydrones



Cyclopée – Hydrones (17/10)

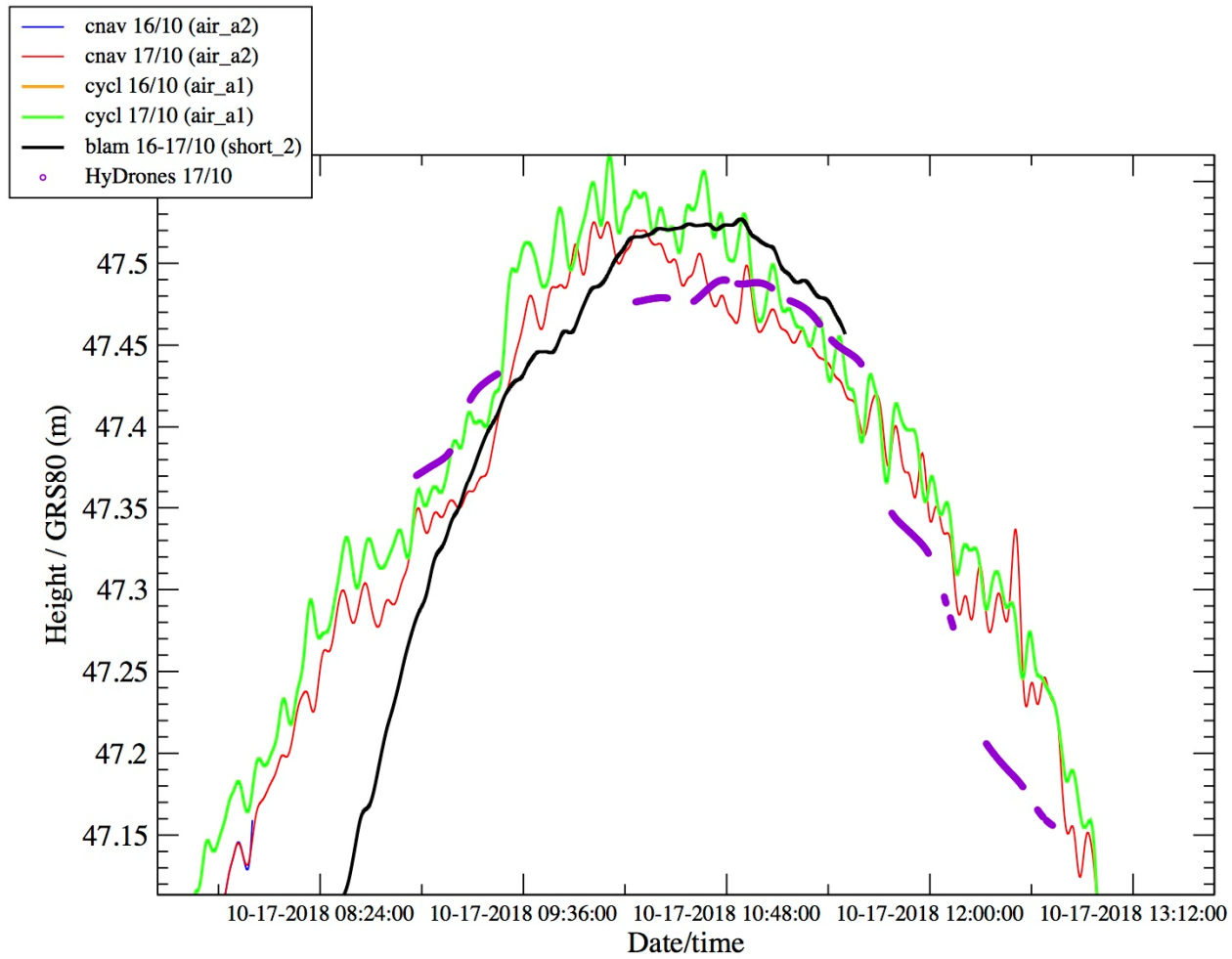
Date	Type	Mean (mm)	$\sigma$ (mm)	N
17/10/18	D<250m	+25.5	40.3	9432
17/10/18	D<250m + V<0.3m/s	-11.6	15.0	6907



CalNaGeo- Hydrones (17/10)

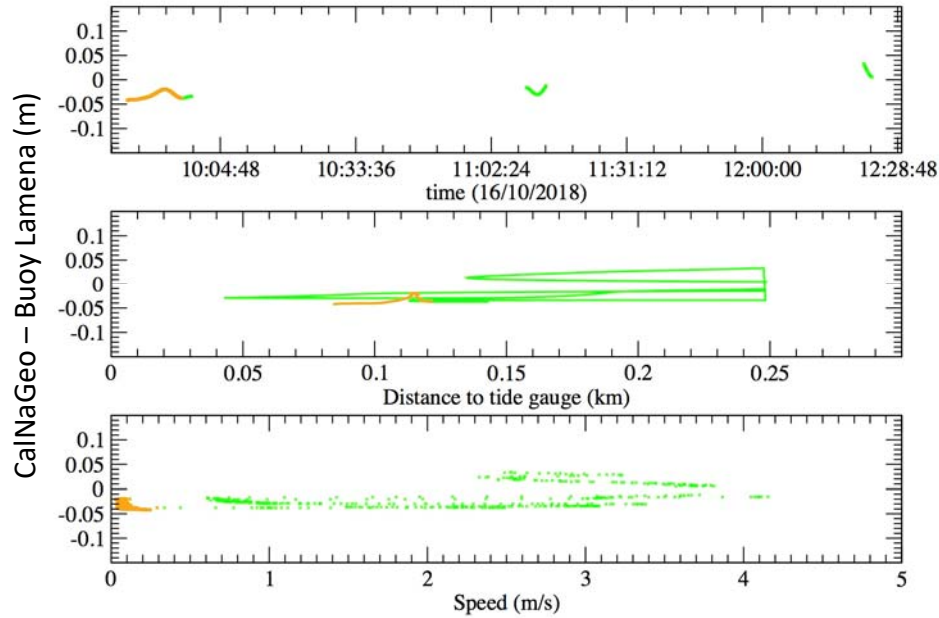
Date	Type	Mean (mm)	$\sigma$ (mm)	N
17/10/18	D<250m	+9.8	44.3	9939
17/10/18	D<250m + V<0.3m/s	-26.9	17.5	3324

Mesures communes le 17/10: série CalNaGeo (rouge), Cyclopée (vert), bouée (noir) et HyDrones (violet)

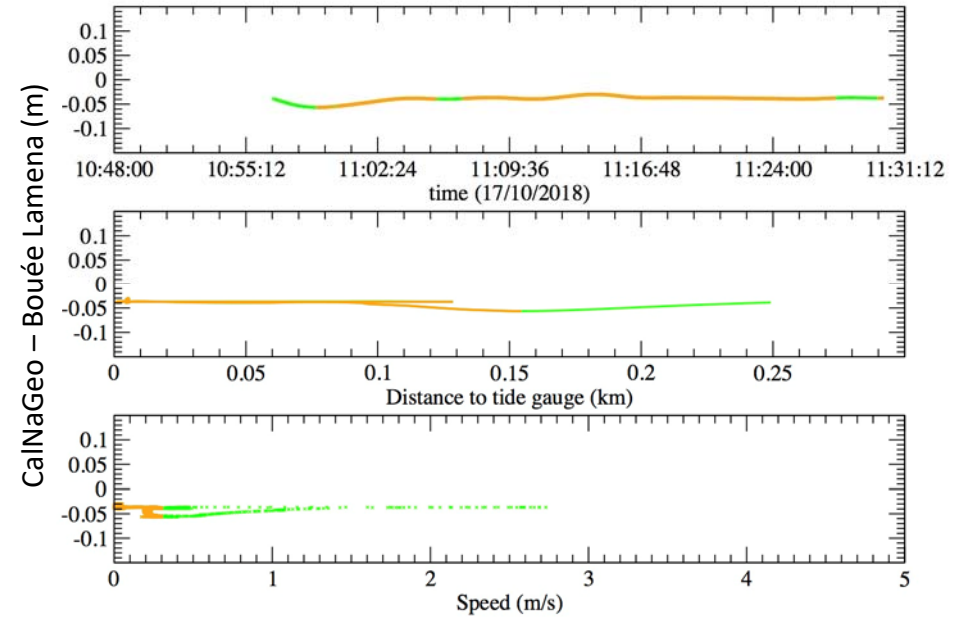


# Comparisons CalNaGeo — Buoy @ Lamena

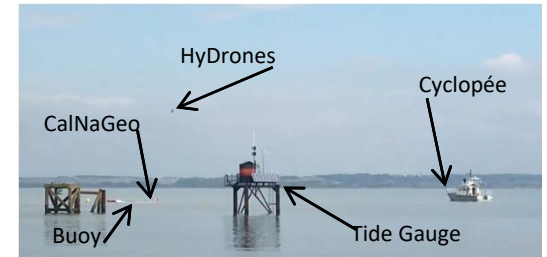
CalNaGeo downstream Experiment @ GIRONDE (Track mode air)



CalNaGeo downstream Experiment @ GIRONDE (Track mode air)

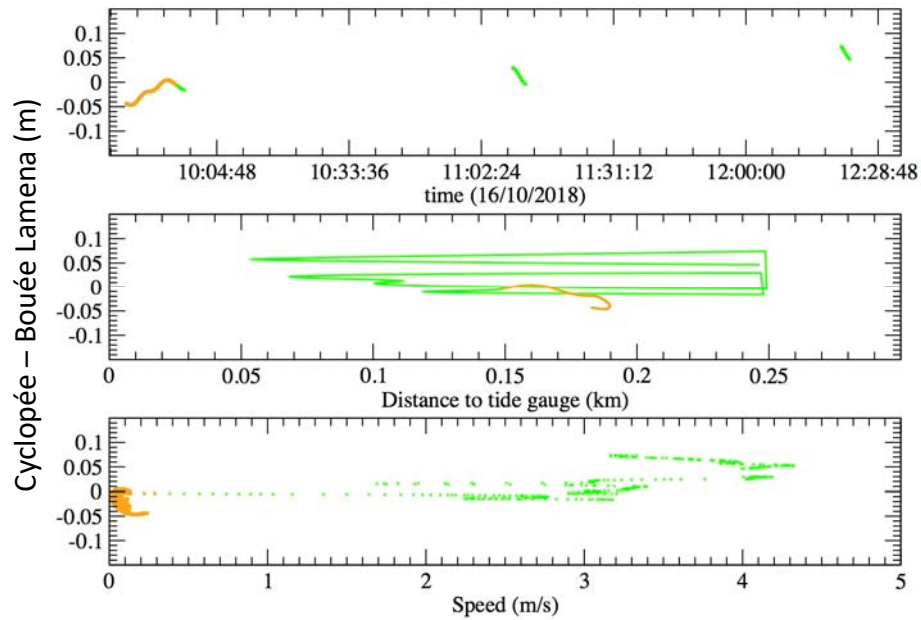


Date	Type	Mean (mm)	$\sigma$ (mm)	N
16/10/18	D<250m	-26.1	15.8	2872
16/10/18	D<250m + V<0.3m/s	-32.0	7.4	1995
17/10/18	D<250m	-39.5	6.0	2566
17/10/18	D<250m + V<0.3m/s	-38.6	5.3	2055

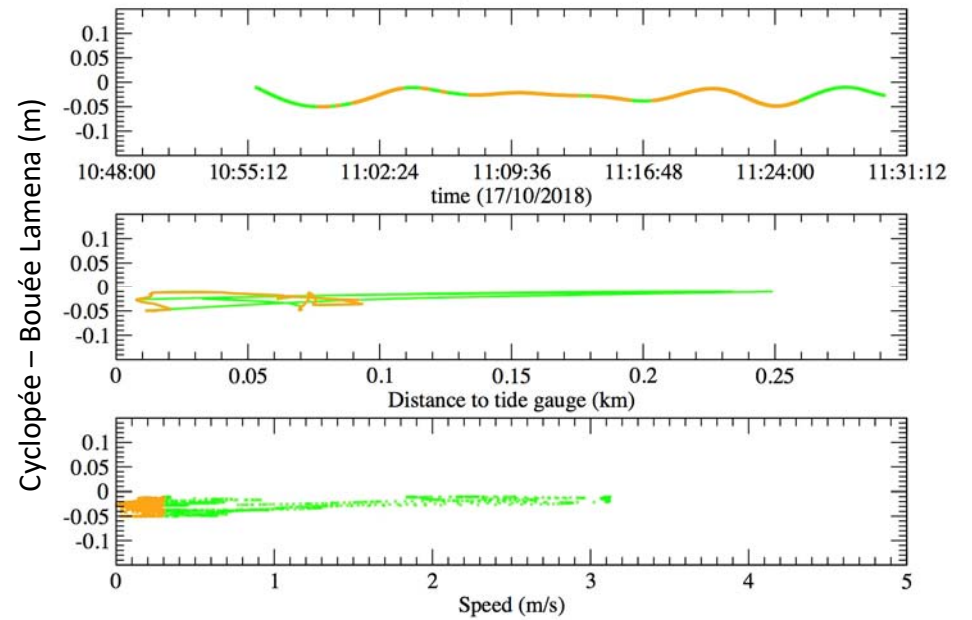


# Comparaisons Cyclopée – Bouée Lamena

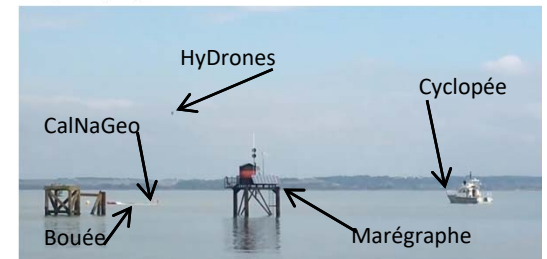
Cyclopee Experiment @ GIRONDE (Track mode air)



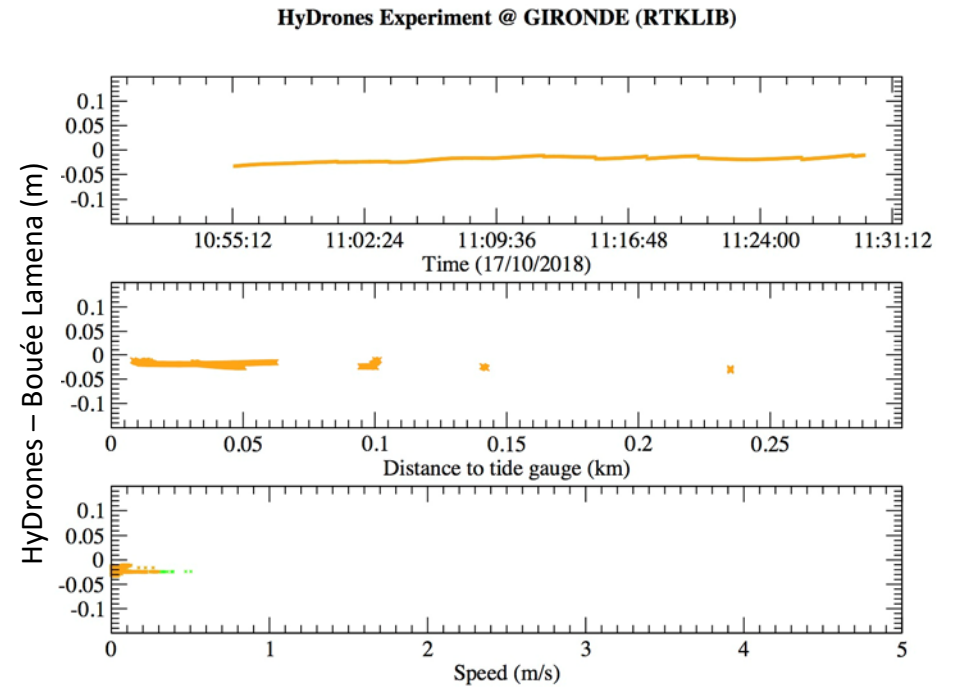
Cyclopee Experiment @ GIRONDE (Track mode air)



Date	Type	Mean (mm)	$\sigma$ (mm)	N
16/10/18	D<250m	-3.9	29.3	3062
16/10/18	D<250m + V<0.3m/s	-19.0	17.5	1940
17/10/18	D<250m	-27.8	11.3	2577
17/10/18	D<250m + V<0.3m/s	-28.4	10.0	1556



## Comparaisons HyDrones – Bouée Lamena



Date	Type	Mean (mm)	$\sigma$ (mm)	N
16/10/18				
16/10/18				
17/10/18	D<250m	-19.0	5.2	2062
17/10/18	D<250m + V<0.3m/s	-19.0	5.2	2062

